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MODIS Reflective Solar Bands Uncertainty Analysis

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A key instrument for the NASA Earth Observing System (EOS) mission, the Moderate Resolution Imaging Spectroradiometer (MODIS), is currently operating on-board the Terra and Aqua spacecrafts. This paper discusses the calibration uncertainty analysis for the MODIS Reflective Solar Bands. Each MODIS, either on the Terra or on the Aqua spacecraft, has 20 reflective solar bands, making observations at three different nadir spatial resolutions: 250m (B1-2), 500m (B3-7), and 1000m (B8-19, and B26). The 250m, 500m, and 1000m bands have 40, 20, and 10 detectors per band, respectively. The reflective solar bands spectral wavelengths are between 0.41 and 2.3 μ m. On-orbit, a solar diffuser is used for the reflective solar bands calibration. For the high gain ocean color bands (B8-16), a retractable attenuation pinhole screen is placed in front of the solar diffuser during each calibration. For the reflective solar bands, the specified uncertainty at the typical scene is 2% in reflectance and 5% in radiance. The uncertainty analysis to be presented in this paper will include the approaches and estimated results for Terra MODIS. Aqua MODIS L1B uncertainty is not reported but is extremely similar to Terra. Emphasis will be on the solar diffuser bi-directional reflectance factor characterization at pre-launch since it is a major contributor to the reflective solar bands uncertainty. Other factors include the Earth view response-versus-scan angle, solar diffuser degradation and attenuation screen effect. For the Terra MODIS instrument, the estimated uncertainties based on the instrument characterization and performance will be compared with the specifications.

1. Introduction

The Moderate Resolution Imaging Spectroradiometer (MODIS) currently operating on-board the Terra and Aqua spacecrafts is a key instrument for the NASA Earth Observing System (EOS) mission^{1,2,3,4}. MODIS covers the spectral range from 0.41 μ m to 14.5 μ m with 36 bands at three spatial resolutions: bands B1-B2 at 250m with 40 detectors, bands B3-B7 at 500m with 20 detectors, and bands B8-B36 at 1km with 10 detectors. The spectral range of MODIS is separated into two distinct groups: the reflective solar bands (visible, near infrared, and short wavelength infrared) and the thermal emissive bands (medium and long wavelength infrared). The emissive bands (TEB) are discussed in an accompanying paper. Table 1 contains key specifications for the reflective solar bands (RSB). The RSB uncertainty specification for a typical scene is 2% in reflectance factor and 5% in radiance.

Each of the RSB bands B13-14 has a low and high gain output. This is accomplished by combining the signal from two banks of ten detectors using time delayed integration (TDI) on each detector pair. The combined detector signals for each band are then amplified using independent low gain and high gain electronic paths. The gain of each detector's electronic path, and in fact for all bands B1-30, can be controlled from the ground station using an 8 bit digital to analog converter (D2A).